

Commentary on David Huron's "On the Role of Embellishment Tones in the Perceptual Segregation of Concurrent Musical Parts"

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ABSTRACT: In his article 'On the Role of Embellishment Tones in the Perceptual Segregation of Concurrent Musical Parts', David Huron (2007) takes four metrics known in the psychological literature to affect perceptual segregation and applies them to embellished versus unembellished versions of 50 of Bach's chorales. In all cases he argues and demonstrates that the embellished versions of the chorales are more likely to induce segregation than the unembellished versions. This commentary concurs with his view, with the possible exception of co-modulation, for which we argue the data and analysis is both rather weak and somewhat unclear in its detail. It is argued in the commentary also that although the data do largely support the view, it is the only conclusion possible as the unembellished chorales are simple monodic devices, of which almost any type of development or embellishment is almost bound to increase the ability of a listener to segregate the parts. We also provide some background historical and cultural context as the use of the chorale in Bach's time, particularly the fact that they were generally sung rather than played or listened to outside a religious setting, has an important bearing on the way they were written.

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ALMOST all serious music students at some point in their education will have been obliged to harmonize Bach chorales from the soprano part alone. So ubiquitous is the use of Bach chorales in the teaching of harmony and counterpoint that almost all musicians have somewhere in their possession a copy of 'Riemenschneider' – the name alone is enough to indicate its subject matter. The use of Bach chorales in the teaching of harmony and counterpoint is not surprising; Bach was the supreme technician and therefore if we want to learn about harmony and counterpoint, this should be our starting point. Many view the chorales as being the perfect balance of harmony (the vertical, momentary aspect of the music) and counterpoint (the horizontal and longer-term component). Neither dominates, but there are moments in the music when one might be more significant than the other. When we listen to any type of music the harmony urges us towards listening to the notes together as a single unit, whereas the counterpoint urges us to listen to the individual lines and also to segregate the streams comprising each of the individual lines over longer periods of time such as a phrase. Thus, a Bach chorale can be heard as potentially a single stream (when the harmonic forces of the music are strong) or up to four separate streams comprising each of the four voices. Professor Huron's article argues that various metrics derived from a subset of Bach's chorales appears to demonstrate that the embellishment tones which Bach added to the chorales conform to known psychological principles which favor segregation of the lines. Thus the basic, unembellished chorales are less likely to be listened to as separate streams than the embellished versions. One cannot really argue with this view as the numbers provided do indeed support this claim, and the underlying musical, cognitive, perceptual and acoustic theory generally backs this up. Indeed, it is very likely that embellished versions of Bach's chorales are more likely to induce styles of listening that allow the listener

to separate the streams, and it is encouraging to see that detailed analysis can bear this out. It would be very surprising if anything else were the case.

THE HISTORICAL AND CULTURAL CONTEXT

The historical and cultural context of Bach's chorales is important because Bach did not have a completely free hand in the way he composed the chorales, as indeed Professor Huron (2007) indicates. Their nature was restricted to some extent by chorales which already existed (which often formed the basis of Bach's chorales), by the likelihood that chorales at least in some circumstances and settings needed to be sung in church services by people who needed to have the 'tune' very clearly delineated, and by the fact that the music had to fit with German words, many of which were extremely emotive and devotional. We can't however be certain what type of congregational participation we are talking about at various periods of Bach's activity. It would drastically change the perspective for example if we assume that they were always performed by a choir or always by a congregation. Although this is a widely discussed topic, mostly with reference to cantatas and passions (Parrott, 1996, 1998; Koopman, 1997, 1998) it seems appropriate to assume that some chorales might have been performed by a congregation and some (especially those from passions) exclusively by a choir. Thus, chorales at the time that Bach wrote them were primarily an aid to worship, and were generally intended to be sung rather than listened to. This simple fact does have an enormous impact on musical solutions which supposedly confused both congregations and Bach's employers (Leaver, 1985). Chorales were governed by proper text setting and word meaning both locally and globally (i.e. through selection of key, mode, halves of circle of fifths, and the use of flats versus sharps). These factors are important in the way embellishments and other alterations are manifested (Marshall, 1970).

That they were generally sung has at least one important psychological implication in terms of segregation of the parts as far as the listener would have been concerned, because the four parts would be easier to segregate on the basis of different timbral qualities of the voices, particularly for example between the low parts which would be sung by men, and the higher parts which would be sung by boys or young men with quite different voices. The chorales were also not necessarily listened to for pleasure or leisure, especially without the all-important words, or in the absence of an appropriate religious setting. These practical issues constrained what Bach could and could not do, and the conditions under which Bach wrote them determined to some extent how the compositions manifested themselves (in the same way for example that music for early pianos reflected the nature and limitations of the instruments on which the music had to be played). The reason that this is important is that if we believe that great composers intuitively understood music perception and cognition (not to mention our emotional responses to music) then we might get better insights into the relationship between music and its cognition by looking at works where composers had a freer hand rather than those where they did not. In some works using chorales Bach did have a much freer hand and the implications for the balance between single channel monodic listening and listening to single, segregated lines become much more evident in these.

Chorales were intended to be in the vernacular, rather than in Latin, with the consequence that long, vowel-rich passages had to be replaced with many shorter and guttural German consonants and syllables (Grew, 1933). Thus we can see the need for embellishment tones start to appear for the simple and pragmatic reason that there were a lot of consonants and syllables to get through within the music. Singers, particularly untrained singers, also tend to add passing notes between larger intervals which may help them to conceptualise what they are singing as a single stream, and also to make the singing easier (we need only think of the passing tone that most congregations sing in the last line of the verse the hymn 'O Come all Ye Faithful', where the word 'angels' is usually sung using a passing note between the major third interval between 'an-' and 'gels'; some hymns books now print this embellishment in the music itself). Chorales of necessity were monodic (this made it easier for the congregation to sing together), and the vocal lines had to be restricted to around a tenth or less because they often had to be sung by untrained singers. Where the congregation sang the 'tune', or *cantus firmus*, this slowly evolved as the soprano part as it was easier to hear than if it was hidden among other voices. Given this context, we can perhaps see that a basic chorale without embellishment is by definition a monodic device unlikely to invoke much perceptual segregation of the parts. Indeed, trying to achieve perceptual segregation in a chorale would have been counter-productive to its purpose. It seems logical therefore that almost any attempt at elaboration of these fundamentally simple musical block structures might lead to greater perceptual segregation of the parts. In Bach's embellishments of the chorales he has taken some steps towards allowing segregation and in the

freer compositions incorporating chorales (or using chorales as their basis) such as cantatas, motets, organ works and passions we would expect that segregation to become more striking. Professor Huron's analysis demonstrates quite clearly how the first steps to achieving a greater focus on polyphony and segregation was achieved by Bach in the way embellishments are used.

THE ANALYSIS OF EMBELLISHMENT TONES

After a detailed presentation on the types of embellishment tones which exist in Bach's chorales, Professor Huron introduces us to the four basic principles (Huron 2001) which are thought to contribute to the perceptual independence of musical parts, and then presents the reader with empirical evidence to support the claim that embellished versions of the chorales will induce greater perceptual segregation than the unembellished versions of the chorales, which can almost be thought of as control stimuli.

Pitch Proximity

Pitch proximity is an important principle which governs (to some extent) whether we hear a stream of sound as a single or more strands. For a sequence of tones where the speed of the music is relatively slow, fusion into a single stream is generally enhanced by having the tones as close to one another in pitch as possible. The analysis shows that the average melodic interval size is smaller for the embellished chorales than for the control chorales. Given that the very nature of embellishment tones is that they tend to fall between the chordal notes in pitch (as Professor Huron points out himself) then this could be seen to be self-evident; there was never any other possible outcome from this analysis. However, the fact that this might have been self-evident does not mean that it should not be demonstrated reliably and empirically. It also reinforces the idea that one of the purposes of the embellishments as far as Bach was concerned was to create a shift from monody to polyphony, and this can only be done by creating some independence of the parts; indeed, as we have mentioned, the singers, whether choir or congregation, might have introduced some simple embellishments of their own. Thus it is clear that greater pitch proximity is present in the embellished than in the unembellished version, and the implication is that identification of a single part (the embellished part) becomes easier, thus enhancing segregation.

Tonal Fusion

Tonal fusion occurs when either two, three or four of the individual tones in the chorale at any one point are consonant with one another. Most obviously this is the unison (which does happen in the chorales from time to time), the octave, and the fifth. If the tones fuse, then they are more likely to be heard as a single stream rather than segregated parts. As tones become more dissonant with one another, so tonal fusion is harder to achieve and thus segregation of the parts is more likely to occur. Professor Huron presents us with a count of the occurrences of duplication of both actual pitches (the unison) and of consonant pitch classes (unisons, octaves, fifteenths and so on) for each of the voices. In fact, hypothesis 2 is a subset of hypothesis 3 as unisons (hypothesis 2) are necessarily included in unisons, octaves, fifteenths and other relatively consonant intervals. Here again, there is no other outcome possible than that the embellished versions of the chorales contain fewer consonant intervals overall, which are measured in terms of the total number of quarter durations spent in one of the consonant intervals included in the analysis. Given that most embellishments are less important to the basic harmonic structure of the chorale than the chordal notes, then they are almost bound to be less consonant than these. With the possible exception of arpeggiation, all the other embellishments listed are likely to decrease the overall consonance of the chorale. But again, there is no harm in demonstrating this empirically and certainly the psychological evidence would suggest that increasing the dissonance between the parts should lead to greater segregation of those parts. Professor Huron takes this analysis further and demonstrates also that if pitch classes are duplicated, then the chances that one of the two notes duplicated is more likely to contain an embellishment. It would be interesting to check whether the text setting itself might be the source of some of this repetition, rather than being driven by enhanced segregation of the parts. Furthermore, whether the intention of the composer was to induce greater segregation of the parts (as Professor Huron suggests) or whether it is a more fundamental compositional device is open to question. In four-part harmony it is important to maintain the tonic, third and fifth of the chord wherever possible. If two voices have the same pitch class, this will mean that if the

composer doesn't select one of the duplicate tones then there will likely be momentary loss (depending on the type of embellishment) of either the only tonic, third or fifth in the chord, which most harmony students and teachers would regard as bad practice. The example given in Figure 4, for example, demonstrates how the third is momentarily lost in the example on the left, which might be one of the reasons why it is not as aesthetically pleasing as the version on the right, which Professor Huron argues is more likely. Thus it might be argued that the finding that duplicated pitch-classes are more likely to contain embellished tones than ones which do not has less to do with segregation of the parts than it does with the maintenance of solid harmony. Therefore this device might equally be considered to induce single-channel listening rather than segregation of the parts.

One other aspect of the tonal fusion analysis is that Professor Huron states early on that of the 50 chorales analysed, 44 are in the major key. Whilst it seems reasonable to accept the judgement that there is likely to be little difference between major and minor chorales in terms of the metrics measured here (the differences are more likely to be associated with the texts used), if the analysis was to go to the level of the third then there might be some important differences between the major and minor chorales.

Co-modulation

Professor Huron's hypothesis here is that chorales without embellishment tones will tend to move in the same direction in terms of their contour (up or down) more frequently than the embellished chorales, and that the lower level of co-modulation in the embellished versions of the chorales again contribute to the segregation of the parts. We assume that the size of the interval change is unimportant and that it is the direction of movement only under consideration here. Professor Huron looks at all 6 possible pairings of the voices (e.g. soprano-alto, soprano-tenor etc) and shows a marginal significant difference where the unembellished versions of the chorales do show a higher degree of co-modulation overall. Not enough detail of the precise method of calculation is given here, because the data is based on 300 correlations which, for 50 chorales and 6 voice pairings each, gives only one correlation between voices for each chorale. This means that the correlations on which the data are based must be for the whole of a chorale, and it is not easy to see how the degree of co-modulation between any two parts for any particular chorale would have been derived. It may have been calculated on a note-by-note basis, with perfect co-modulation being given a score of 1, and if so it would be useful to know how contrary motion was dealt with and also how the correlations might have been influenced by the total number of possible co-modulations within and between chorales. Given that the pitch proximity and the tonal fusion analysis was measured through a simple count, a simple count may have been appropriate here too. For example, it might have been possible simply to count the number of times the two parts being investigated moved in the same direction as a proportion of the total number of tones in the chorale for each voice pairing (this may well be what was done, though scored as a correlation). Of course, this analysis would be easier for the unembellished versions of the chorales than for the embellished versions, which would have been problematic when there were more notes in one part than another (particularly for the soprano part, which typically has fewer notes). The issue here is that the methodology is not clear; whether the correlations are based on global or local measurements is not really explained, and given that the correlations are relatively weak, it would be important to detail exactly how they were derived. Whether it was possible to test the significance level of the correlations is also of some relevance, as discussed below.

The data here do not provide a totally convincing argument that the embellished versions possess a lower degree of co-modulation than the unembellished versions. Of the 300 correlations obtained, 166 are in favour of the unembellished versions and 131 in favour of the embellished versions. Although the statistical test presented (chi-squared, on the total number of correlations) does provide some support at a global level, there appear not to be any criteria (other than being numerically higher or lower) for assessing the significance (or otherwise) of each of the correlations. It could be that for some of the chorales the differences between embellished and unembellished versions in much greater (and/or statistically significant) than for others (which might not be statistically different between embellished and unembellished versions). If the chi-squared analysis compared only those differences which had been found to be statistically significant from the correlational analysis, the picture might have been quite different. Also, given that the sample analysed are only 50 of a much larger set of chorales, it might be safer to reserve judgement on this particular matter. So here, the data is somewhat less than convincing.

Psychologically, reducing the co-modulation of the parts is likely to increase the ability of the listener to segregate the parts, but the data do not unambiguously support the case for the chorales analysed.

Reducing co-modulation is also important in avoiding consecutive fifths and octaves, which are usually to be avoided for harmonic reasons rather than for increasing the segregation of the parts. So again the underlying reason for this phenomenon may be motivated more by harmony than by counterpoint. Of course, consecutive fifths and octaves should increase fusion, which may in part account for the strange harmonic sense produced particularly by consecutive fifths as the greater fusion might draw attention to the harmony. This is an interesting psychological question in itself.

Onset asynchrony

The final piece of analysis is that of onset asynchrony. Research evidence suggests that segregation is more likely to be achieved when the parts are not synchronized in time. Here, Professor Huron rightly points out that the mere addition of embellishment tones will increase the level of onset asynchrony and presents data which shows, indeed, that the presence of embellishment tones increases the likelihood of onset asynchrony by some 44%. The analysis which follows is much more interesting in that he presents us with an analysis of turn-taking in the parts on the basis that our attention to a part is momentarily drawn to that part if it contains an embellishment. One stage of the analysis demonstrates that the proportion of asynchronous tones is similar across all parts (except the soprano part with which fewer liberties could be taken). The most interesting hypothesis is that the part most likely to have the next asynchronous tone is the part that has gone the longest without an asynchronous note. The analysis partly supports this view as it shows that the predictability of the part to contain the next asynchronous onset is higher if it is the voice which had its last asynchronous onset the longest ago. No inferential statistics are presented, but the predictability across all four voices is 32% (chance level would be 25%). There was variability across the voices, being highest (49%) in the soprano part and lowest (chance level) for the bass part. Professor Huron interprets the lack of predictability of turn-taking in the bass part as possibly being due to the composer's relative lack of options for introducing embellishments in the part which forms the basis for the harmony, but given that overall the bass parts appear to contain as many embellishments as the alto and tenor parts, it is difficult to be convinced by this argument. In a single chorale there can only be so many opportunities for turn-taking but as the analysis of turn-taking tends to look at the chorales more globally, we might assume that Bach would have had the opportunity, had he wished to take it, but chose not to. Thus the answer to this question remained unanswered.

However the analysis of turn-taking as a whole certainly does seem to suggest that turn-taking is indeed occurring in the chorale, and the interpretation would be that this encourages segregation of the parts by momentarily focusing the listener on to one of the four parts, making it the focus for a short while, and is certainly consistent with the argument presented by Sloboda & Edworthy (1981) which suggests that at any one time one part is in the 'foreground' and the others are in the 'background'. We can assume that the more recently the part has been pushed to the foreground, the more likely it is to receive particular attention, and the longer it remains unembellished, the further it will fall into the background. Professor Huron's juggling analogy works well and conveys the point he is making quite clearly: As the ball is reaching the floor, the individual part which has not been refreshed for some time becomes less and less salient, and therefore an embellishment is more likely to be applied just before the ball hits the floor – when the part has reached such a low salience that its presence needs to be reinforced. Of course, without experimentation we do not know how close to the floor the ball has reached. If we believe that composers had an intuitive understanding of perceptual and cognitive mechanisms, we could assume that the floor is looming imminently. In terms of understanding this from a cognitive psychological perspective, the involvement of the time-based elements of working memory may present some useful frameworks in which to think and theorise about this issue.

CONCLUSION

Professor Huron's paper in general presents a convincing analysis that embellishment tones do indeed encourage perceptual segregation, and the background theory used to support his claims is generally well established. The numerical methods applied to the chorales work on the whole, though there are some areas where the support provided could be stronger and less ambiguous. However, starting from the monody of the unembellished chorales, it would be hard to argue otherwise, or indeed expect it to be otherwise. The empirical data presented here is of course all about the chorales themselves, and not about human

perception. If this paper lacks anything, then it is empirical evidence derived from human listeners. Such evidence would strengthen the claims enormously, and also put the claims into some sort of perspective. For example, there are a number of experimental tasks which have been used to investigate the degree to which participants are listening to the parts as a whole or are segregating the parts, and any one or more of these could be usefully employed to get at the degree to which listeners would typically attend to the chorale as a single unit of sound or as separate parts. Professor Huron himself has done a considerable amount of work in this area. Such work could establish the extent to which segregation increases with embellishment, and the degree to which recently unembellished parts have slipped into the background. One important issue is the question of the degree to which the parts are truly being segregated even in the embellished forms. If for example the segregation of the parts is negligible in the unembellished chorales, how much does it change with the addition of the embellishments? The increase in segregation might be very large, or it might be only slightly higher than in the unembellished forms. Without experimentation however it is impossible to know. Given that the chorales represent only a step along the way of Bach's move towards a freer use of the chorale, we would expect those works (such as chorales when used in cantatas, motets, organ works and so on) to induce much greater segregation than the 'basic' chorales themselves. Professor Huron's use of Professor Bregman's quote (1990, p.521) about hearing Beethoven in one ear and Bach in the other demonstrates quite clearly this issue of degree, as the degree to which we could expect segregation in even embellished chorales might be expected to be quite low in comparison to many other listening contexts. Experimentation is needed to back up the hypotheses and claims presented in this paper.

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